



## MARVIN-5MP

### 5 Megapixel Camera Interface

The 5 Megapixel Camera Interface DesignObject™ (MARVIN-5MP\*) is a complete video and still picture input unit which is targeted on SoCs with image capture capability as used in mobile phones with integrated cameras. MARVIN-5MP contains image processing, scaling and compression functions. The integrated image processing functions allow simple CMOS sensors without any image preprocessing to be supported as well as sensors with integrated YCbCr processing.

Scaling is used for downsizing the sensor data in order to display an image on a connected LCD, or for generating a YCbCr 4:2:0 data stream for video compression. Output data is transmitted via an AHB interface. All functional blocks can be configured using an on-chip microprocessor via an AHB slave interface.

The scalers can handle up- and downscaling as well as format conversions of YCbCr formats. True Digital Zoom is supported in a two step approach, where the image in the first step is written to system memory and in the second step is read back from system memory and up-scaled. All data is transmitted via the AHB master interface into system memory. The memory locations are programmable depending on the

data to be stored. Besides using the parallel camera interface, camera sensors can be connected through serial interfaces according to the MIPI or SMIA standard. MARVIN-5MP can easily be adapted to lower or higher image resolution, e.g. for saving gate count or memory.

MARVIN-5MP represents a complete video and still picture input unit. It contains image processing (ISP), scaling and JPEG compression functions. For displaying on LCD the MARVIN-5MP also includes a function to convert YCbCr back to display-ready RGB format. In this case the input format has to be YCbCr 4:2:2. In addition, the display-ready RGB data can be rotated in 90° steps.

### Applications

- Mobile phones with integrated cameras
- Mobile applications requiring a megapixel still image or video input
- SoCs with image capture capability

### Key Features

- Image processing and image improvement
- Image scaling of main and self picture
- Compression functions for still picture and video
- JPEG encoding on-the-fly

\*MARVIN-5MP was formerly part of the sci-worx GmbH product portfolio. Silicon Image acquired sci-worx in January 2007.

MARVIN-5MP Gate Count

	Gates	Ram
JPEG	83K	41kByte
Other Functions	414K	44kByte

Gate = 2 Input-NAND equivalent, using TSMC 0.13  $\mu\text{m}$  process and standard cell libraries

# Marvin-5MP Features

## Main Picture Scaler & Self Picture Scaler

Two blocks are used to scale the image to the resolution needed for capturing, viewfinding or encoding. They use separate scaling engines for luminance and chrominance processing. This enables both color components to be handled independently and thus allows format conversion from YCbCr 4:2:2 to 4:2:0, 4:1:1, 4:1:0, and even 4:4:4 using different scaling factors for luminance and chrominance. The scaler in self-picture path is able to up-scale up to VGA resolution for adapting image resolution and format from the system memory input I/F.

## Features

- 12-bit camera interface (RGB Bayer input)
- MIPI & SMIA serial input interface
- Maximum input resolution of 5.3 Megapixels (2600 x 2048)
- Bad pixel detection and correction
- Lens shade correction (vignetting)
- Video image stabilization support
- Auto focus measurement
- Auto white balancing
- Auto exposure support by brightness measurement
- Histogram calculation
- Flash light control
- Mechanical shutter support
- Black level compensation
- Enhanced color interpolation (RGB Bayer demosaicing)
- Sharpening / blurring / noise filter
- Color correction matrix (cross talk matrix)
- Digital image effects (emboss, sketch, sepia, grayscale, color selection, negative image)

- Super impose, digital zoom & continuous resize support
- ITU-R BT.601 & 656 compliant video interface
- HW JPEG encoder including JFIF1.02 stream generator with programmable quantization and Huffman tables
- Display-ready RGB output in self-picture path
- Rotation in 90° steps for display-ready RGB output
- Max. 105 MHz system & max. 100 MHz sensor clock
- YCbCr 4:2:2 and 4:2:0 processing
- Frame skip support for video encoding (e.g. MPEG-4)
- Format conversion between YCbCr 4:2:2, 4:2:0, 4:1:1 and 4:1:0 formats
- Planar and semi-planar storage format for YCbCr
- 32-bit AHB master interface to system memory supporting four and eight beat bursts
- Power management by software-controlled clock disabling for currently not needed sub-modules

## Color Processing

This module is designed for color adjustments. It can be used to adjust contrast, brightness, saturation and hue.

## Image Effects

A set of image effects is supported which includes sepia, greyscale, color section, negative, emboss and sketch. The image effects block is also available for post processing of images through the DMA read feature of MARVIN-5MP.

## Superimpose

This module overlays an image with a bitmap from the main memory. The color of the transparent area in the superimpose bitmap is configurable. In addition this block is able to position a bitmap with the appropriate coordinates over the camera image range.

## JPEG Decoder (optional)

An optional JPEG decoder may be inserted for post-processing and display of JPEG images, which could in addition be used for efficient storage of superimpose bitmaps.

## Y/C Splitter

The Y/C SPLIT module is responsible for providing component separated YCbCr 4:2:2 pixel data for further processing.

## JPEG Encoder

The hardware JPEG encoder accepts YCbCr 4:2:2 data up to a resolution of 2600x2048 pixels (5.3 MPixel). It encodes the data and produces a JFIF 1.02 compliant stream, hence no stream post-processing is required.

## Memory Interface

The MI is responsible for writing the image data stream either color component combined or color component separated into system memory.

## Control Unit

The CTRL block is the interface between the internal PVC1 port from MARVIN-5MP's AHB slave and local configuration blocks. It allows access to a set of configuration registers. A host CPU is required for static and dynamic configuration of these registers during operation of MARVIN-5MP.



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